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Research article

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**New members of the genera *Neanura* MacGillivray, 1893 and
Deutonura Cassagnau, 1979 (Collembola: Neanuridae)
from the Middle East**

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Abstract. New species of *Neanura* MacGillivray, 1893 and *Deutonura* Cassagnau, 1979 are described from northern Iran. Both taxa are characterized by unusual features that place them in isolated positions within the genera. *Neanura deharvengi* sp. nov. differs from congeners by the extreme reduction of head chaetotaxy and fused lateral tubercles on the head. These characteristics of the new species broaden the existing diagnosis of the genus *Neanura*. An updated diagnosis is provided herein. *Deutonura persica* sp. nov. is most similar to *D. plena* (Stach, 1951), known from the Carpathians. The new species can be distinguished by the strong reduction of its head, labial, and labral chaetotaxy as well as the relative length of chaetae De2 and De3 on abdominal segments I–III. The Iranian records of *D. decolorata* (Gama & Gisin, 1964) are questioned. Brief remarks on the importance of the newly described species for the knowledge of both genera are also provided.

Keywords. Springtails, Neanurinae, Western Palaearctic, Iran.

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Introduction

In recent years, there have been a series of publications about Iranian species in the subfamily Neanurinae (Shayanmehr *et al.* 2013; Mayvan *et al.* 2015; Smolis *et al.* 2012, 2016a, 2016b, 2017). To date, the local fauna of this subfamily encompasses 13 species classified into 8 genera. Due to the size and diversity of

Iran these numbers are certainly an underestimate. Confirming this, we supply the descriptions of two new Iranian species of this group.

The genus *Neanura* MacGillivray, 1893 is the oldest taxonomic unit in the subfamily. Cassagnau (1979) redefined the genus and split it into four subgenera: *Neanura* sensu stricto, *Cryptonura*, *Deutonura* and *Endonura*. Shortly after, this was expanded by Deharveng (1982b). As currently understood, *Neanura* includes only 7 species (Deharveng 1982b; Buşmachi & Deharveng 2008; Smolis & Deharveng 2017). The distribution of most of them, excluding the cosmopolitan *N. muscorum* (Templeton, 1835), is restricted to Europe, especially to the western and central parts of the continent. Taxonomically, *Neanura* is probably most closely related to the Siberian genus *Kalanura* Smolis, 2007, from which it differs in the arrangement of lateral tubercles and the relative length of chaetae A and B on the head (Smolis 2007).

In contrast to the genus *Neanura*, *Deutonura* Cassagnau, 1979 is nowadays one of the largest genera of Neanurinae, comprising 57 valid species (e.g., Deharveng 1982a; Deharveng & Weiner 1984; Porco *et al.* 2010; Deharveng *et al.* 2015). The highest diversity of the genus is documented for western Europe; for example, 19 species have been recorded in France (Deharveng *et al.* 2015). Due to the fusion of tubercles Di and De on the head and tubercles Di on the penultimate abdominal segment, *Deutonura* strongly resembles the monotypic genus *Albanura* Deharveng, 1982, although it differs from the latter by having separate tubercles Di on abdominal tergite IV (fused in *Albanura*) and by the number of chaetae Di on abdomen V (3+3 or very rarely 2+2 chaetae in *Deutonura*, 2+2 in *Albanura*) (Deharveng 1982b).

In the present contribution, we describe *Neanura deharvengi* sp. nov. and *Deutonura persica* sp. nov. from northern Iran. The former species is especially interesting since it possesses two unusual characters: extreme reduction of cephalic chaetotaxy and fused lateral tubercles on the head. Nevertheless, this new species is also characterised by several features (i.e., 3+3 eyes, the cross-type arrangement of chaetae on the head, separateness of cephalic chaetae D1 and presence of male ventral organ) which are characteristic of the genus *Neanura*. It convinced us that a new genus shouldn't be erected for it at the moment and that the diagnosis of *Neanura* can be modified to accommodate the new species. We additionally include short remarks on the published record of *D. decolorata* (Gama & Gisin, 1964) from Iran and on the global distribution of the genera *Neanura* and *Deutonura*.

Material and methods

Specimens were collected from soil and litter samples. The samples were extracted using a Berlese-Tullgren apparatus. Specimens were cleared in Nesbitt's fluid, subsequently mounted on slides in Swan's medium and studied using a Nikon Eclipse E600 phase contrast microscope. Figures were drawn with a camera lucida and prepared for publication using Adobe Photoshop CS3. The material is deposited in the Department of Invertebrate Biology, Evolution and Conservation, Institute of Environmental Biology, University of Wrocław, Poland (DIBEC).

Terminology and abbreviations

The terminology for the descriptions follows those of Deharveng & Weiner (1984), Smolis & Deharveng (2006) and Smolis (2008).

The following abbreviations are used in the text, figures and tables:

General morphology:

Abd. = abdomen

Ant. = antenna

AOIII = sensory organ of antennal segment III
Cx = coxa
Fe = femur
Scx2 = subcoxa 2
T = tibiotarsus
Th. = thorax
Tr = trochanter
VT = ventral tube

Groups of chaetae:

Ag = antegenital
An = chaetae of anal lobes
ap = apical
ca = centroapical
cm = centromedial
cp = centroposterior
d = dorsal
Fu = furcal
Ve or ve = ventroexternal
Vea = ventroexternoanterior
Vec = ventroexternocentral
Vei = ventroexternointernal
Vel = ventroexternolateral
Vem = ventroexternomedial
Vep = ventroexternoposterior
vc = ventrocentral
Vi or vi = ventrointernal
Vl = ventrolateral

Tubercles:

Af = antenna-frontal
Cl = clypeal
De = dorsoexternal
DE, EE = elementary tubercles on head
Di = dorsointernal
Dl = dorsolateral
L = lateral
Oc = ocular
So = subocular

Types of chaetae:

B4, B5 = ordinary chaetae on tibiotarsi
brs = border s-chaeta on Ant. IV
bs = s-chaeta on Ant. IV
i = ordinary chaeta on Ant. IV
iv = ordinary chaetae on ventral Ant. IV
L' = ordinary lateral chaeta on Abd. V
Mc = short macrochaeta
Mcc = very short macrochaeta

me	= mesochaeta
mi	= microchaeta
miA	= microchaetae on Ant. IV
MI	= long macrochaeta
mou	= cylindrical s-chaetae on Ant. IV ('soies mousses')
ms	= s-microchaeta
Oca, Ocm, Ocp	= ocular chaetae on head
or	= subapical pit of Ant. IV
S or s	= chaeta s
sgd	= dorsal s-chaeta on Ant. III
sgv	= ventral s-chaeta on Ant. III
x	= labial papilla x

Results

Class Collembola Lubbock, 1873
Order Poduromorpha Börner, 1913
Family Neanuridae Börner, 1901
Subfamily Neanurinae Börner, 1901
Tribe Neanurini Salmon, 1951

Genus *Neanura* MacGillivray, 1893

Type species

Achorutes muscorum Templeton, 1835.

Since the new species described below is characterized by a number of characters unknown in other members of the genus, e.g., the absence of cephalic chaetae A and the fusion of lateral tubercles on the head into one mass, the currently accepted diagnosis of the genus as proposed by Deharveng (1982) is emended here. Moreover, three recently erected genera (*Kalanura*, *Xylanura* Smolis, 2011 and *Persanura* Mayvan *et al.*, 2015; see Smolis 2007, 2011 and Mayvan *et al.* 2015) morphologically strongly resemble the genus *Neanura*. As a result, its diagnosis requires extension based on new morphological characters (e.g., relative length of cephalic chaetae A and B, presence of tubercles Di on Abd., arrangement of tubercles on Abd. V, presence of male ventral organ) diagnostic and useful for generic characterization within the tribe Neanurini.

Emended diagnosis

Body colour blue to grey or whitish. Eyes with 3+3 dark pigmented ocelli. Dorsal tubercles and reticulations present, well developed. Abdominal segments IV and V subequal in length. Chaetotaxy of body and appendages not polychaetotic. Ant. IV with 8 subequal S-chaetae. Labral chaetotaxy 4/2, 4 or 2/2,4. Mouthparts reduced, maxilla styliform, mandible tridentate. Tubercles Af and Cl on head separate. Chaetae A on head present or rarely absent. If present, chaetae A and B of same length. Chaetae Ocp on head present or absent. Head with tubercles (DI + L) and So or rarely they are fused into single mass. Sometimes tubercle (L+DI) on head consists of two parts (L+1/2DI) and DI'. Arrangement of chaetae Di and De on head of cross-type, line of chaetae Di2–De2 crosses line Di1–De1. Tubercles Di and De on head separate. Tubercles Di on Th. I present or absent. Th. II–III with 3 chaetae Di. Tubercles Di on Abd. I–IV present. Tubercles Di never fused on abdominal segment IV, but fused, partially fused or separate on Abd. V. Each half of Abd. V with 3 or 2 chaetae Di. Cryptopygy absent or slightly developed. Abd. VI bilobed. Furcal remnant without microchaetae. Chaeta L' present or absent. Adult males usually with

modified chaetae on ventral side of abdomen (male ventral organ). Tibiotarsi with 19, 19, 18 chaetae, clavate chaetae absent. Claw without inner tooth.

Neanura deharvengi sp. nov.

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Figs 1–2; Table 1

Diagnosis

Habitus typical of genus. Dorsal tubercles present and well developed. Body colour light bluish grey. Buccal cone short, labrum without ogival sclerifications. Dorsal cephalic chaetotaxy strongly reduced: chaetae A, C, O, E, Ocp, DI5, DI3, So2, So6 and L2–3 absent. Tubercles Di on Th. I absent. Abd. I–III without chaetae De3. Tubercle (Di+Di) of Abd. V with 2+2 chaetae, chaetae Di2 absent. Cryptopygy absent. Male ventral organ present.

Etymology

The new species is dedicated to our colleague and friend Louis Deharveng for his magnificent contribution to our knowledge of Collembola.

Material examined

Holotype

IRAN: adult ♀, on slide, Mazandarn Province, Behshahr Region, Abbas-Abad Forest, 36°40' N, 53°32' E, leaf litter and soil, 28 Mar. 2013, E. Yoosefi-Lafooraki leg. (DIBEC).

Paratypes

IRAN: adult ♂ and subadult ♂, on slides, same collection data as for holotype (DIBEC).

Other material

IRAN: juvenile, on slide, Mazandarn Province, Noor Region, Kadirsar village, 36°26' N, 51°49' E, leaf litter and soil, 1 Mar. 2013, E. Yoosefi-Lafooraki leg. (DIBEC).

Description

BODY. Length (without antennae): 0.58 to 0.80 mm (holotype: 0.8 mm). Body convex. Colour of body light bluish grey. 3+3 black eyes of medium size, in typical arrangement of genus (two anterior and one posterior).

CHAETAL MORPHOLOGY. Dorsal ordinary chaetae of three types: long macrochaetae (MI), mesochaetae and microchaetae. Long macrochaetae relatively thick, slightly arc-like or straight, narrowly sheathed, feebly serrated, mostly apically rounded or rarely, mainly in lateral position, pointed (Figs 1A–B, 2C). Mesochaetae similar to ventral chaetae, thin, smooth and pointed. Microchaetae similar to mesochaetae but shorter. S-chaetae of tergites thin, smooth and short, notably shorter than nearby macrochaetae (Figs 1A–B, 2C, E–F).

ANTENNAE. Typical of genus. Ant. I–II with 7 or 11 ordinary chaetae, respectively. Ant. III with 5 S-chaetae (AOIII) and 18 ordinary chaetae: 5 d, 4 vi, 4 vc and 5 ve (Fig. 1F). Ant. IV dorsally with complete set of chaetae: 8 S, or, i, 12 mou and 3 brs (Fig. 1E). S-chaetae of Ant. IV of medium length, subequal and moderately thickened. Apical vesicle distinct, trilobed (Fig. 1C–D). Ant. IV ventrally with complete set of chaetae (3 brs, 2 iv; ap: 8 bs and 5 miA; ca: 2 bs and 3 miA; cm: 3 bs and 1 miA; cp: 8 miA and 1 brs).

MOUTHPARTS. Buccal cone relatively short, with labral sclerifications non-ogival. Labrum chaetotaxy: 2/2, 4 (Fig. 2A). Labium with four basal, three distal and four lateral chaetae, papillae x absent. Maxilla styliform, mandible thin and tridentate.

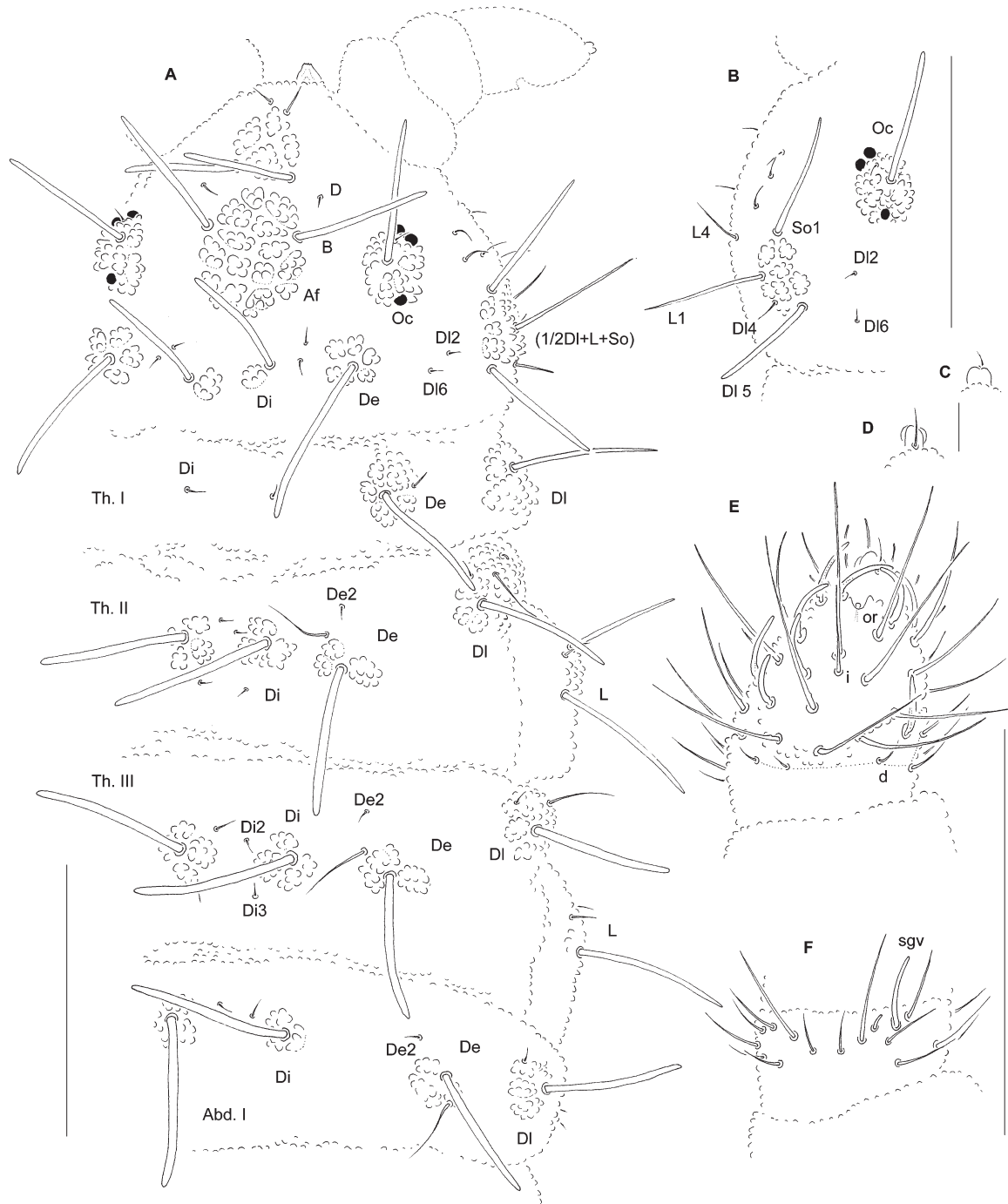


Fig. 1. *Neanura deharvengi* sp. nov. **A.** Dorsal chaetotaxy of head, Th. and Abd. I. **B.** Lateral chaetotaxy of head. **C.** Apical bulb, ventral view. **D.** Apical bulb, dorsal view. **E.** Dorsal chaetotaxy of Ant. III–IV. **F.** Ventral chaetotaxy of Ant. III. Scale bars: A–B, E–F = 0.1 mm; C–D = 0.01 mm.

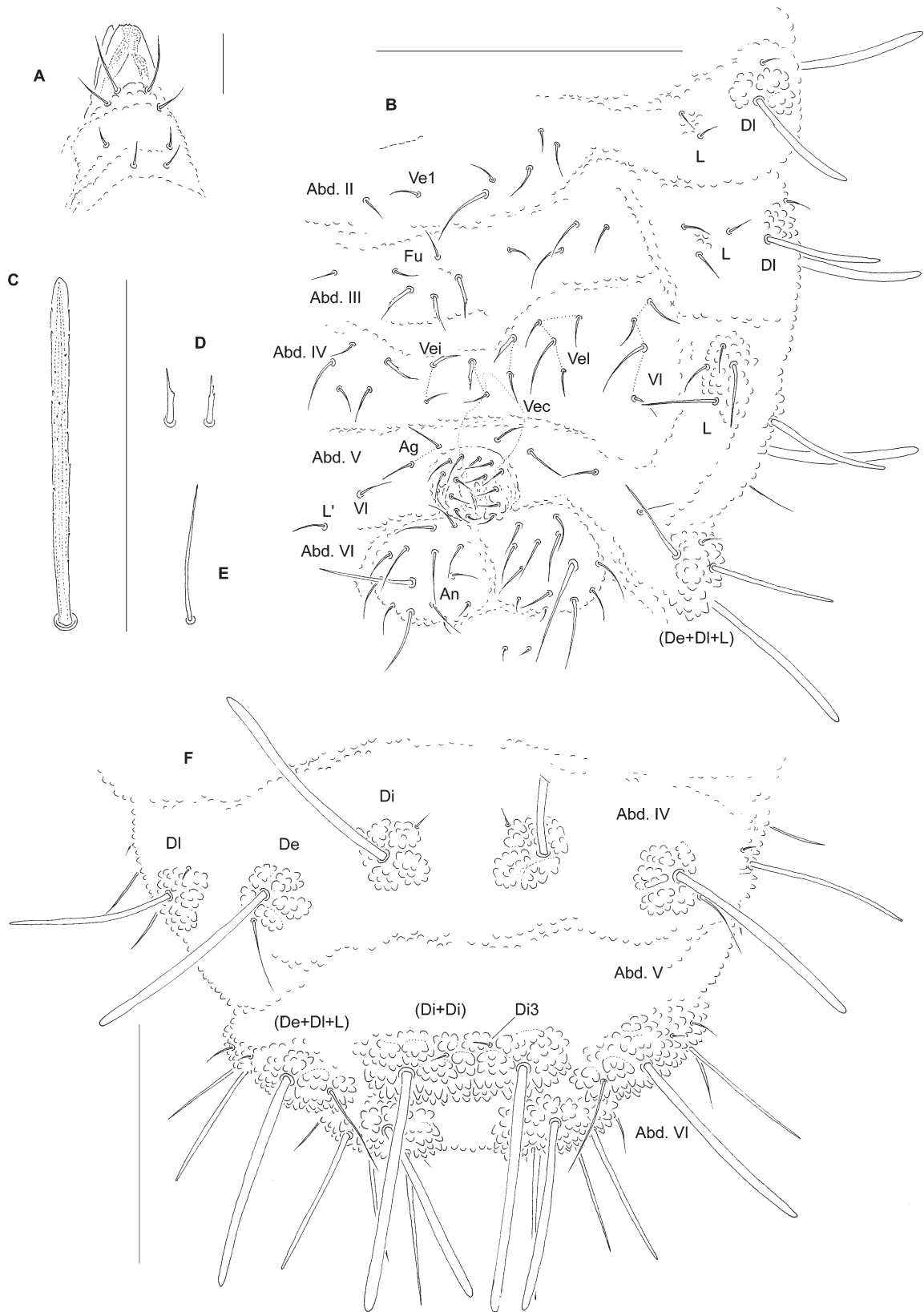


Fig. 2. *Neanura deharvengi* sp. nov. **A.** Labrum. **B.** Ventral chaetotaxy of Abd. II–VI, adult male. **C.** MI Di1 of Abd. V. **D.** Modified chaetae of male ventral organ. **E.** Sensillum of Abd. V. **F.** Dorsal chaetotaxy of Abd. IV–VI. Scale bars: A = 0.01 mm; B–F = 0.1 mm.

Table 1a. Chaetotaxy of *Neanura deharvengi* sp. nov.: cephalic chaetotaxy–dorsal side.

Tubercle	Number of chaetae	Types of chaetae	Names of chaetae
Cl	4	Ml me	F G
Af	4	Ml mi	B D
Oc	2	Ml mi	Ocm Oca
Di	2	Ml mi	Di1 Di2
De	2	Ml mi	De1 De2
(DI+ L+So)	8	Ml me mi	DI5, L1, So1 DI4, L4 So3–5

Table 1b. Chaetotaxy of *Neanura deharvengi* sp. nov.: postcephalic chaetotaxy.

	Tergites				Scx2	Cx	Legs		
	Di	De	DI	L			Tr	Fe	T
Th.I	1	2	1	-	0	3	6	13	19
Th.II	3	2+s	2+s+ms	3	2	7	6	12	18
Th.III	3	2+s	2+s	3	2	8	6	11	18
					Sternites				
Abd.I	2	2+s	2	2	VT: 4				
Abd.II	2	2+s	2	2	Ve: 5–6		Ve1 - present		
Abd.III	2	2+s	2	3	Ve: 4		Fu: 5 me, 0 mi		
Abd.IV	2	1+s	3	4	Ve1: 2	Vec:2	Vel: 4	VI: 4	
Abd.V	(2+2)	5+s			Ag: 2	VI: 1	L':1		
Abd.VI	7				Ve: 12–13		An: 2 mi		

DORSAL CHAETOTAXY AND TUBERCLES. Head with fused tubercles So and (L+1/2DI) (Fig. 1A–B). Cephalic chaetae DI2, DI6 and L4 free. Th. II–III with free chaetae Di2, Di3 and De2. On Th. II–III, chaetae De3 and DI3 absent. On Abd. I–III, line of chaetae De1–chaeta s nearly parallel to dorsomedian line. On Abd. I–III chaetae De2 free (Fig. 1A). Abd. V with 3 tubercles: (Di+Di) and 2 (De+DI+L). On Abd. V chaetae Di2 absent. No cryptopygy, Abd. VI visible from above (Fig. 2F).

VENTRAL CHAETOTAXY. On head, groups Vea, Vem and Vep with 3 chaetae each; group Vi with 6 chaetae. On Abd. V, 2+2 chaetae Ag, chaetae VI and L' present. Male with thick and forked chaetae (“male ventral organ”) in groups Vei and Vec (Abd. IV), and in Fu (Abd. III; Fig. 2B, D).

LEGS. Claw without internal tooth. On tibiotarsi, chaeta M present and chaetae B4 and B5 relatively short and pointed.

Remarks

Neanura deharvengi sp. nov. is most similar to *N. pallida* Deharveng, 1979 and *N. minuta* Gisin, 1963, both of which are also characterized by the presence of chaetae L' on Abd. V, the absence of chaetae Ocp on the head and tubercles Di on Th. I. Besides the unique characters of the new species, a reduction

of cephalic chaetotaxy and a fusion of lateral tubercles on the head, these species can additionally be distinguished by the following features: coloration (whitish to pale bluish in *N. deharvengi* sp. nov. and *N. pallida*; dark bluish in *N. minuta*), chaetotaxy of head (chaetae A, C, E, D11, D13, So2, So6 and L2–3 absent in *deharvengi* sp. nov.; present in *pallida* and *minuta*), number of ordinary chaetae De on Th. II and III (2, 2, respectively, in *deharvengi* sp. nov.; 2, 3 in *pallida*; 3, 4 in *minuta*), number of ordinary chaetae De on Abd. I–III (2 in *deharvengi* sp. nov.; 3 in *pallida* and *minuta*), number of chaetae Di on Abd. V (2+2 in *deharvengi* sp. nov.; 3+3 in *pallida* and *minuta*) and number of tubercles on penultimate abdominal segment (3 in *deharvengi* sp. nov.; 4 in *pallida* and *minuta*).

The only other member of the genus besides *N. deharvengi* sp. nov. recorded to date from Iran is *N. muscorum* (Cox 1982; Yahyapour 2012). These species are significantly dissimilar and differ in a number of characters including, e.g., cephalic chaetae Ocp (absent in *deharvengi* sp. nov.; present in *muscorum*), tubercle Di on Th. I (absent in *deharvengi* sp. nov.; present in *muscorum*), the number of chaetae De on Th. II and III (2+s, 2+s, respectively, in *deharvengi* sp. nov.; 3+s, 4+s in *muscorum*), male ventral organ (present in *deharvengi* sp. nov.; absent in *muscorum*), chaetae L' on Abd. IV (present in *deharvengi* sp. nov.; absent in *muscorum*), and the number of tubercles on Abd. V (3 in *deharvengi* sp. nov.; 4 in *muscorum*).

Genus *Deutonura* Cassagnau, 1979

Type species

Achorutes phlegraeus Caroli, 1912.

Deutonura persica sp. nov.

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Figs 3–4; Table 2

Diagnosis

Habitus typical of genus. Dorsal tubercles present and well developed. Body white, with 2+2 dark pigmented eyes. Buccal cone short, labrum without ogival sclerifications. Cephalic tubercles Af and Cl generally not fused. No granular area between chaetae A and B. Head without chaetae O, C, E, D13, L2 and L3. Th. III with 3+s chaetae De. Tubercles Di on Abd. V not bilobed. Cryptopygy present and strongly developed. Male ventral organ present.

Etymology

The specific epithet '*persica*' refers to the historical name of Iran, the *terra typica* of the new species.

Material examined

Holotype

IRAN: adult ♀, on slide, Mazandarn Province, Neka Region, Hezarjarib Forest, 36°37' N, 53°21' E, dead wood, 28 Mar. 2013, E. Yoosefi Lafooraki leg. (DIBEC).

Paratypes

IRAN: 4 adult ♀♀, 2 adult ♂♂, 1 subadult ♂, 1 juvenile, on slides, collected from moss on tree, leaf litter, dead wood in a hole of Persian ironwood (*Parotia persica*), same collection data as for holotype (DIBEC).

Description

BODY. Length (without antennae): 0.49 to 1.50 mm (holotype: 0.85 mm). Body slightly flattened. Body colour white. 2+2 medium black eyes, in typical arrangement for genus.

CHAETAL MORPHOLOGY. Dorsal ordinary chaetae of five types: long macrochaetae (Ml), short macrochaetae (Mc), very short macrochaetae (Mcc), mesochaetae and microchaetae. Long macrochaetae thickened, subcylindrical, slightly arc-like or straight, narrowly sheathed, serrated, apically rounded or rarely, in lateral part of body, pointed (Figs 3B, F–G, 4B). Macrochaetae Mc and Mcc thickened, slightly fusiform, straight and apically rounded. Mesochaetae similar to ventral chaetae, thin, smooth and pointed. Microchaetae similar to mesochaetae, but distinctly shorter. S–chaetae of tergites thin, smooth and short, distinctly shorter than nearby macrochaetae (Figs 3B, F–G, 4B–C).

ANTENNAE. Typical of genus. Ant. I–II with 7 or 11 ordinary chaetae, respectively. Ant. III with 5 S–chaetae (AOIII) and 17 ordinary chaetae: 4 d, 4 vi, 4 vc and 5 ve (Fig. 3A, I). Sensillum sgv long and thin. Ant. IV dorsally with the complete set of chaetae: 8 S, or, i, 12 mou and 3 brs. S–chaetae of Ant. IV of medium length, subequal and moderately thickened. Apical vesicle distinct, trilobed (Fig. 3C–D). Ant. IV ventrally with complete set of chaetae (3 brs, 2 iv; ap: 8 bs and 5 miA; ca: 2 bs and 3 miA; cm: 3 bs and 1 miA; cp: 8 miA and 1 brs). Dorsal chaeta d5 absent on Ant. III.

MOUTHPARTS. Buccal cone relatively short, with labral sclerifications non-ogival. Labrum chaetotaxy: 2/2, 4 (Fig. 3H). Labium with four basal, three distal and three lateral chaetae, papillae x absent (Fig. 3E). Maxilla styliform, mandible thin and tridentate.

DORSAL CHAETOTAXY AND TUBERCLES. Head without granular area between chaetae A and B. Chaetotaxy of head strongly reduced (Fig. 3B, F). Elementary tubercles DE and EE on head absent. Cephalic chaetae A distinctly shorter than B. Chaetae Ocm and Ocp of nearly equal length. Chaetae De2 on head usually as mi, rarely as Mcc. Chaetae Di2 on head as mi or Mcc (Fig. 3B, F). Chaetae Di 3 on Th. II–III free (Fig. 3B). On Th. III, chaetae De2 longer than De3. On Abd. I–III chaetae De2 shorter than De3 (Fig. 3G). Chaeta Di2 on Abd. V as microchaeta, Di3 as mi or Mcc. Cryptopygy strong, Abd. VI hardly visible from above.

VENTRAL CHAETOTAXY. On head, groups Ve_a, Ve_m and Ve_p with 4, 3, 4 chaetae respectively (Fig. 3F); group Vi with 6 chaetae. On Abd. IV, furcal rudiment with 4 microchaetae (Fig. 4A). Tubercle L on Abd. IV with 5–6 chaetae. Male with thick and forked chaetae (“male ventral organ”) on even anal valves (Abd. VI), in groups Ve_i, Ve_c and Ve_l (Abd. IV), and Fu (Abd. III; Fig. 4A).

LEGS. Claw without internal tooth. On tibiotarsi, chaeta M present and chaetae B4 and B5 relatively short and pointed.

Variability

A complete fusion of the cephalic tubercles Af and Cl has been observed in a single specimen. Nevertheless, based on the available material it is hard to assess definitively whether it is just an aberrant form or an example of morphological variation within the species.

Remarks

Using the recent published key of the genus (Deharveng *et al.* 2015), *Deutonura persica* sp. nov. seems to be most similar to *D. plena* (Stach, 1951), a species described and only known from the Western and Eastern Carpathians. These two taxa, however, can easily be distinguished using a number of characters: chaetae C and E on the head (absent in *persica*; present in *plena*), elementary tubercles DE and EE on the head (absent in *persica*; present in *plena*), number of lateral chaetae (L+So) on the head (8 in

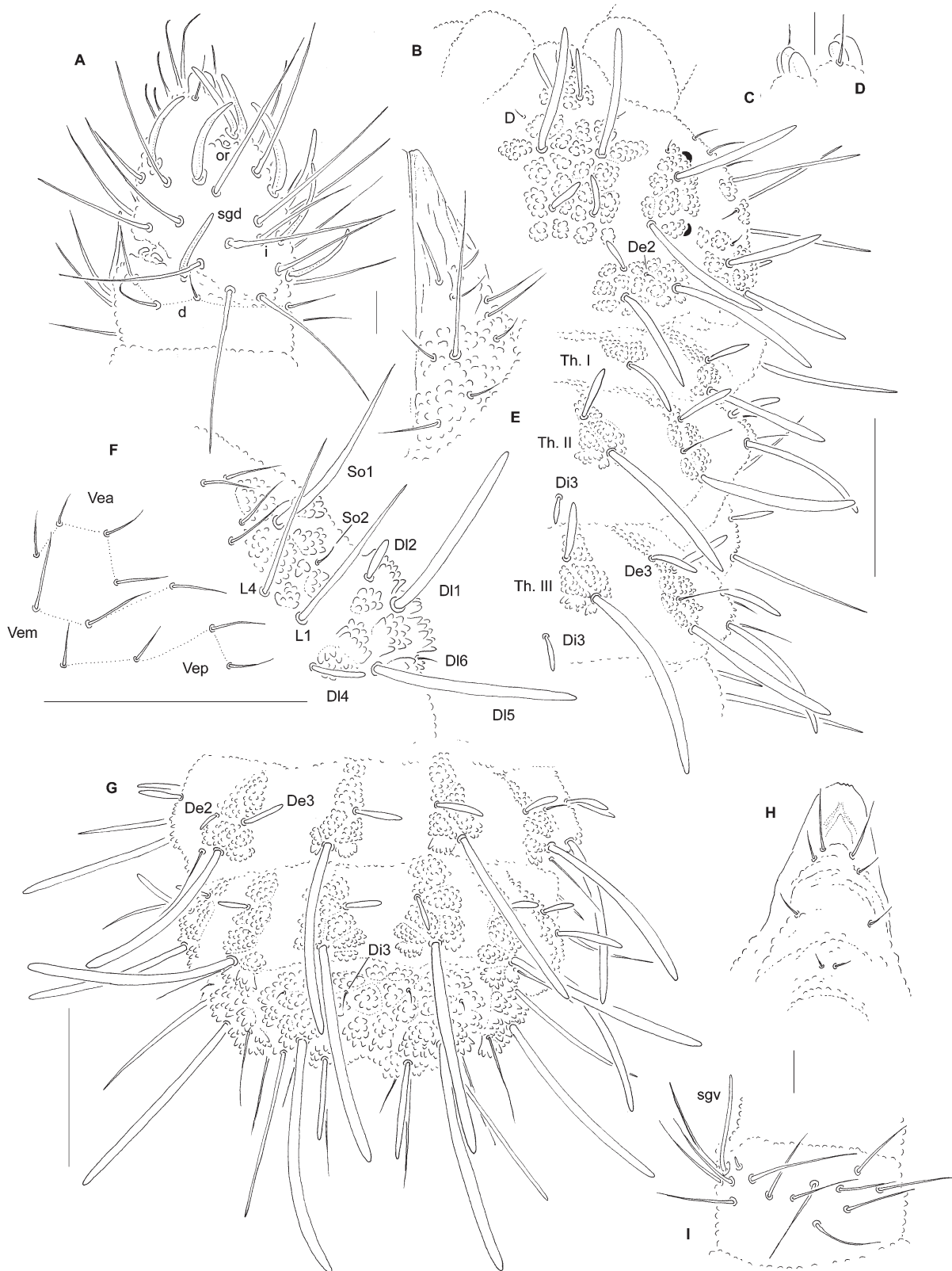


Fig. 3. *Deutonura persica* sp. nov. **A.** Dorsal chaetotaxy of Ant. III–IV. **B.** Dorsal chaetotaxy of head and Th. **C.** Apical bulb, ventral view. **D.** Apical bulb, dorsal view. **E.** Chaetotaxy of labium. **F.** Ventral and lateral chaetotaxy of head. **G.** Dorsal chaetotaxy of Abd. III–VI. **H.** Labrum. **I.** Ventral chaetotaxy of Ant. III. Scale bars: A, C–E, H–I = 0.01 mm; B, F–G = 0.1 mm.

Table 2a. Chaetotaxy of *Deutonura persica* sp. nov.: cephalic chaetotaxy–dorsal side.

Tubercle	Number of chaetae	Types of chaetae	Names of chaetae
Cl	4	Mc	F
		me	G
Af	6	Ml	B
		Mc	A
		mi	D
Oc	3	Ml	Ocm, Ocp
		mi	Oca
(Di+De)	4	Ml	Di, De1
		Mc or Mcc	Di2
		Mcc or mi	De2
Dl	5	Ml	DI1, DI5
		Mcc	DI4
		Mcc or mi	DI2
		mi	DI6
(L+So)	8	Ml	L1, L4, So1
		me	So3–6
		mi	So2

persica; 10 in *plena*), number of prelabral chaetae (2 in *persica*; 4 in *plena*), number of lateral chaetae on the labium (3 in *persica*; 4 in *plena*), microchaetae on Fu (present in *persica*; absent in *plena*), male ventral organ (present in *persica*; absent in *plena*) and relative length of chaetae De2 and De3 on Abd. I–III (De3 longer than De2 in *persica*; De3 shorter than De2 in *plena*).

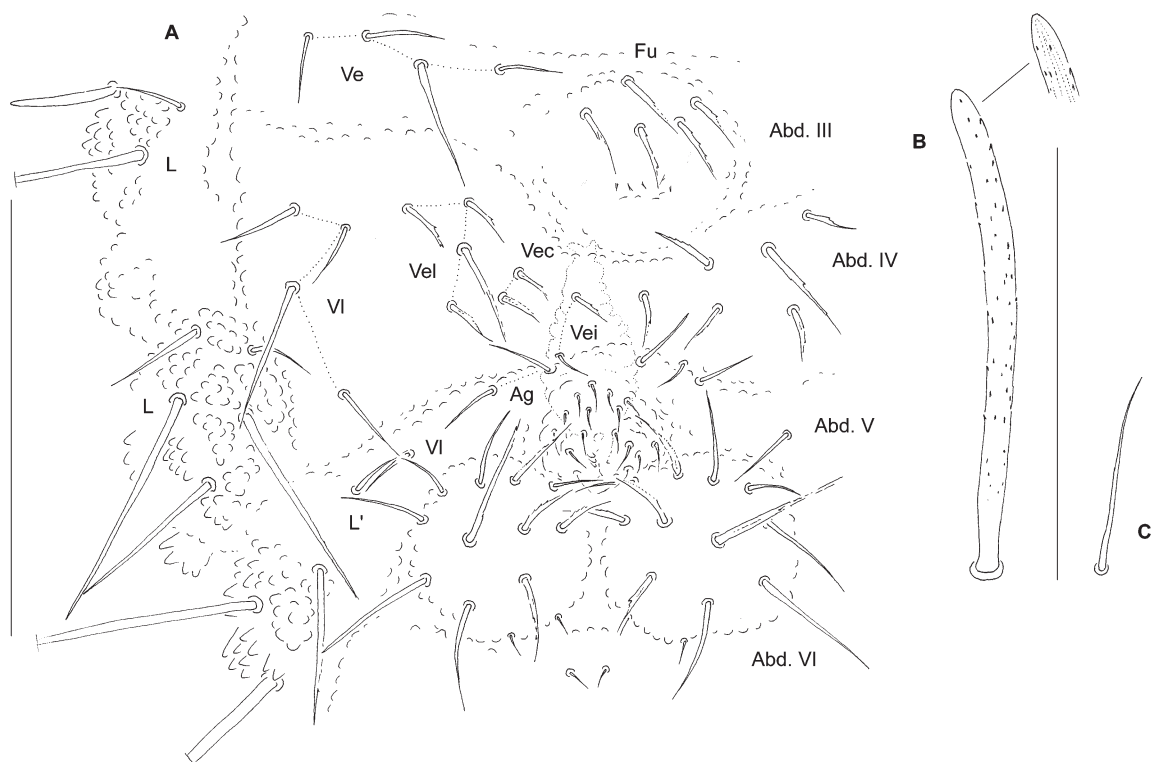


Fig. 4. *Deutonura persica* sp. nov. **A.** Ventral chaetotaxy of Abd. III–VI, adult male. **B.** MI DI1 of Abd. V. **C.** Sensillum of Abd. V. Scale bars: A–C = 0.1 mm.

Table 2b. Chaetotaxy of *Deutonura persica* sp. nov.: postcephalic chaetotaxy.

	Tergites				Legs				
	Di	De	DI	L	Scx2	Cx	Tr	Fe	T
Th.I	1	2	1	-	0	3	6	13	19
Th.II	3	2+s	3+s+ms	3	2	7	6	12	18
Th.III	3	3+s	3+s	3	2	8	6	11	18
					Sternites				
Abd.I	2	3+s	2	3	VT: 4				
Abd.II	2	3+s	2	3	Ve: 5		Ve1 - present		
Abd.III	2	3+s	2	3	Ve: 4		Fu: 4–5 me, 4 mi		
Abd.IV	2	2+s	3	5–6	Vei: 2	Vec:2	Vel: 4	VI: 4	
Abd.V	(3+3)	4+s			Ag: 2	VI: 1	L':1		
Abd.VI	7				Ve: 11–12		An: 2 mi		

Only one species of *Deutonura*, *D. decolorata* (Gama & Gisin, 1964), has previously been recorded (Cox 1982; Shayanmehr *et al.* 2013) from Iran. This species was described and is otherwise known only from the French Alps (Gisin 1964; Porco *et al.* 2010). Because of the fused cephalic tubercles Af and Cl, *D. decolorata* belongs to the small *conjuncta* species group, containing only 4 European species (Deharveng 1979). We have detected a similar fusion of cephalic tubercles in a single individual of *D. persica* sp. nov. (see Variability). In light of the known distribution of *D. decolorata* and the above observation, the record of *D. decolorata* from Iran should probably be treated as highly uncertain.

Discussion

The two new taxa described in this paper broaden and enrich our knowledge of the genera *Neanura* and *Deutonura*, especially with regard to their morphology and biogeography. For example, as mentioned in the Introduction, the genus *Neanura*, excluding the cosmopolitan *N. muscorum*, is primarily restricted to western and central Europe. The discovery of *N. deharvengi* sp. nov. has shown that other species of the genus can be expected outside Europe. In addition, the new species is characterized by a peculiar set of characters, including the absence of chaetae A on the head. Although many genera and species of Neanurinae are characterized by a more or less advanced degree of reduction of cephalic chaetotaxy, these processes usually do not include the mentioned chaetae. For instance, within the Western Palaearctic a similar reduction of chaetae A is observed exclusively in the genus *Bilobella* Caroli, 1912, belonging to Paleonurini, another tribe of Neanurinae (e.g., Deharveng 1981; Smolis & Kaprus' 2008).

In contrast to the previous genus, the range of *Deutonura* is notably broader as its members are distributed both in the Western Palaearctic (western, southwestern, and central Europe, northern Africa; 46 species) and in the Eastern Palaearctic (Korea, Japan and Russian Far East; 11 species). Two species are exceptions to this general distribution pattern: *D. frigida* (Yosii, 1969), which ranges from central Siberia (the basin of the Yenisei river) to north-eastern America (Deharveng & Weiner 1984; Babenko & Fjellberg 2006) and *D. gibbosa* Porco, Bedos & Deharveng, 2010, which was probably introduced by humans to South Africa (Deharveng *et al.* 2015). In spite of the fact that more than 80% of the known members of the genus occur in the Western Palaearctic, the range of *Deutonura* in the region is highly concentrated and localized. For example, there are no species of *Deutonura* in such areas as the British Isles, Scandinavia, the Balkan Peninsula, Crimea, Asia Minor, or the islands of the East Mediterranean Basin (e.g., Rhodes, Crete, Cyprus). The absence of *Deutonura* in northern Europe is easy to understand, as the Neanurinae fauna of these areas is generally impoverished. The rest of the present picture can probably be explained by incompleteness of our knowledge. Nevertheless, some areas like Greece (including Crete and Rhodes), Albania, Bulgaria, Turkey, or the Caucasus have been more or less well investigated for Neanurinae diversity and many species belonging to the subfamily have been recorded

there (e.g., Cassagnau & Péja 1979; Ellis 1976; Deharveng 1982a, 1982b; Smolis & Kuznetsova 2016). The observed gap in the known distribution of *Deutonura* is striking, and the answer to this question can undoubtedly be pivotal to understanding its history and evolution.

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References

- Babenko A. & Fjellberg A. 2006. Collembola Septentrionale. A Catalogue of Springtails of the Arctic Regions. KMK Scientific Press Ltd, Moscow.
- Buşmachi G. & Deharveng L. 2008. Neaurinae and Morulinae of Moldova (Collembola: Neauridae), with description of *Neanura moldavica* sp. nov. *Zootaxa* 1714: 61–66.
- Cassagnau P. 1979. Les collemboles Neauridae des pays Dinaro-Balkaniques: leur intérêt phylogénétique et biogéographique. *Biologia Gallo-Hellenica* 8: 185–203.
- Cassagnau P. & Péja N. 1979. Diagnoses préliminaires de quelques Neauridae de Grèce et d’Albanie. *Biologia Gallo-Hellenica* 8: 205–222.
- Cox P. 1982. The Collembola fauna of north and north western Iran. *Entomologist’s Monthly Magazine* 118: 39–43.
- Deharveng L. 1979. Contribution à la connaissance des collemboles Neaurinae de France et de la Péninsule Ibérique. *Travaux de Laboratoire d’Écobiologie des Arthropodes Édaphiques, Toulouse* 1 (4): 1–61.
- Deharveng L. 1981. Nouvelles espèces de Neaurinae européens appartenant aux genres *Bilobella* et *Monobella*. *Bulletin de la Société d’Histoire naturelle de Toulouse* 117: 95–102.
- Deharveng L. 1982a. *Contribution à l’étude des Collemboles Neaurinae: évolution, spéciation, polymorphisme somatique et chromosomique des formes européennes*. PhD thesis, University of Paul Sabatier, Toulouse.
- Deharveng L. 1982b. Clé de détermination des genres de Neaurinae (Collembola) d’Europe et de la Région Méditerranéenne, avec description de deux nouveaux genres. *Travaux de Laboratoire d’Écobiologie des Arthropodes Édaphiques, Toulouse* 3 (4): 7–13.
- Deharveng L. & Weiner W.M. 1984. Collembola de Corée du Nord III–Morulinae et Neaurinae. *Travaux de Laboratoire d’Écobiologie des Arthropodes Édaphiques, Toulouse* 4: 1–61.
- Deharveng L., Moloud S.A. & Bedos A. 2015. A new species of *Deutonura* (Collembola: Neauridae: Neaurinae) from Algeria, with revised diagnosis of the genus and key to western Palaearctic species. *Zootaxa* 4000 (4): 464–472. <https://doi.org/10.11646/zootaxa.4000.4.5>
- Ellis W.N. 1976. Autumn fauna of *Collembola* from Central Crete. *Tijdschrift voor Entomologie* 119: 221–236.
- Gisin H. 1964. Collembola d’Europe. VI. *Revue suisse de Zoologie* 71 (2): 383–400. <https://doi.org/10.5962/bhl.part.75615>
- Mayvan M.M., Shayanmehr M., Smolis A. & Skarżyński D. 2015. *Persanura hyrcanica*, a new genus and species of Neaurinae (Collembola: Neauridae) from Iran, with a key to genera of the tribe Neaurini. *Zootaxa* 3918: 552–558. <https://doi.org/10.11646/zootaxa.3918.4.4>

- Porco D., Bedos A. & Deharveng L. 2010. Description and DNA barcoding assessment of the new species *Deutonura gibbosa* (Collembola: Neanuridae: Neanurinae), a common springtail of Alps and Jura. *Zootaxa* 2639: 59–68.
- Shayanmehr M., Yahyapour E., Kahrarian M. & Lafooraki E. 2013. An introduction to Iranian Collembola (Hexapoda): an update to the species list. *ZooKeys* 335: 69–83.
<https://doi.org/10.3897/zookeys.335.5491>
- Smolis A. 2007. *Kalanura*—a new genus of Neanurini (Collembola, Neanuridae, Neanurinae) from Siberia, with description of four new species. *Zootaxa* 1511: 1–16.
- Smolis A. 2008. Redescription of four Polish *Endonura* Cassagnau, 1979 (Collembola, Neanuridae, Neanurinae), with a nomenclature of the ventral chaetae of antennae. *Zootaxa* 1858: 9–36.
- Smolis A. 2011. *Xylanura oregonensis*, a new genus and species of saproxylic springtail (Collembola: Neanuridae: Neanurinae) from North America, with a key to genera of the tribe Neanurini. *The Pan-Pacific Entomologist* 87 (1): 15–26.
- Smolis A. & Deharveng L. 2006. *Vitronura mascula*, a new species of Neanurinae (Collembola: Neanuridae) from northern Vietnam, with a key to the species of the genus. *Revue suisse de Zoologie* 113: 263–268. <https://doi.org/10.5962/bhl.part.80349>
- Smolis A. & Deharveng L. 2017. *Neanura judithae* n. sp. from Polish Carpathians, with an updated and illustrated key to all species of the genus *Neanura* MacGillivray, 1893 (Collembola: Neanuridae). *Zoosystema* 39 (1): 37–47. <https://doi.org/10.5252/z2017n1a5>
- Smolis A. & Kaprus' I.J. 2008. *Bilobella carpatica*, a new species of Neanurinae (Collembola: Neanuridae) from the Carpathians. *Revue suisse de Zoologie* 115 (3): 509–514.
<https://doi.org/10.5962/bhl.part.80440>
- Smolis A. & Kuznetsova N. 2016. Remarkable diversity of the genus *Endonura* Cassagnau, 1979 (Collembola: Neanuridae: Neanurinae) in the Caucasus. *Zootaxa* 4200 (1): 47–82.
<https://doi.org/10.11646/zootaxa.4200.1.2>
- Smolis A., Falahati A. & Skarżyński D. 2012. The genus *Cryptonura* Cassagnau, 1979 (Collembola, Neanuridae, Neanurinae) in Iran. *Zootaxa* 3530: 51–58.
- Smolis A., Skarżyński D., Kahrarian M. & Kaprus' I.J. 2016a. Redescription of *Protanura papillata* Cassagnau & Delamare Deboutteville, 1955 (Collembola, Neanuridae, Neanurinae), with new records from Middle East, and with supplemented diagnosis and key to the genus. *Zootaxa* 4092 (2): 293–300.
<https://doi.org/10.11646/zootaxa.4092.2.11>
- Smolis A., Kahrarian M., Piwnik A. & Skarżyński D. 2016b. *Endonura* Cassagnau in Iran, with a key of the genus (Collembola, Neanuridae, Neanurinae). *ZooKeys* 553: 53–71.
<https://doi.org/10.3897/zookeys.553.6009>
- Smolis A., Shayanmehr M, Kuznetsova N. & Lafooraki E.Y. 2017. Three new remarkable species of the genus *Endonura* Cassagnau, 1979 from the Middle East and Central Asia (Collembola, Neanuridae, Neanurinae, Neanurini). *ZooKeys* 673: 135–151. <https://doi.org/10.3897/zookeys.673.12084>
- Yahyapour E. 2012. *Faunistic Study on Collembola (Insecta: Apterygota) in Sari Regions, Vol. 1*. MSc thesis, *Sari Agricultural Science and Natural Resources University, Iran*. [In Persian with English abstract.]

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